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Patentanmeldung Nr. Patent application No. Demande de brevet n°

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R C van Dijk

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Anmelder/Applicant(s)/Demandeur(s):

Koninklijke Philips Electronics N.V.
Groenewoudseweg 1
5621 BA Eindhoven
PAYS-BAS

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
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Method for processing a series of image frames representing a cardia cycle

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Method for processing a series of image frames representing a cardiac cycle

The invention relates to a method for processing a series of image frames representing a cardiac cycle in order to identify from said series of image frames a systolic frame showing a heart in its systolic phase, and a diastolic frame showing the heart is its diastolic phase.

Generally it is required to identify the systolic phase and the diastolic phase of a heart under examination in order to be able to determine further heart parameters such as the stroke volume, the ejection fraction and other parameters. Normally, the systolic phase and the diastolic phase of the heart can be easily determined by means of an ECG-signal. When, however, such an ECG-signal is not available or when it is not possible to avail of this ECG-signal the problem occurs that in order to be able to assess a variety of heart parameters it is a prerequisite that an accurate determination of the systolic phase and the diastolic phase of the heart are determined.

From WO 01/82787 an automatic method for evaluating image data taken over a sequence of image frames is known that is used to determine a contour of a left ventricle of a heart under examination. In this known method end diastole and end systole aortic valve points are entered whereby an initial end diastole region/end systole region classifier is developed using a probability look-up table. Also provided are training data determined from manually drawn contours of hearts of other individuals than the person under examination. Regression coefficients derived from the training data are then applied to determine the end diastole boundary and the end systole boundary which can be used to calculate an ejection fraction for the heart. This known method is complicated and requires much manual input in order to be able to obtain the diastole and systole boundaries of the heart.

It is an object of the invention to provide an effective easy and simple manner of identifying the frames that are representative for the systolic phase and the diastolic phase of the heart under examination.

According to the invention the method includes to this end the steps that

a) each frame from said series is compared with every other frame from said series and a measure of identity for each such comparison between every combination of two frames is established, and that

b) a first frame and a second frame from said series of images showing the lowest value of said measure of identity, are selected, whereby the first frame is identified as the systolic frame and the second frame is identified as the diastolic frame.

Surprisingly, it is possible with the method according to the invention to determine both the systolic frame and the diastolic frame of a heart under examination from a series of image frames representing a complete cardiac cycle, without the need to rely on further measurements such as the ECG-signal.

Although the method of the invention can be applied with any type of image frames such as the image frames derived from a CT-scan, a MRI-scan or an ultrasound scan, the method of the invention is particularly useful when used on a series of images that are derived from an MRI-scan. When collecting a series of image frames with an MRI-scan the problem is that the ECG-signal that is otherwise available can not be used because the ECG corrupts the MRI-frames on the one hand, whereas on the other hand the ECG-signal is disturbed by the magnetic fields of the MRI-scan.

In practice it appears that any suitable way of comparing the frames is feasible. The method according to the invention can, however, be particularly well applied when the comparison between every combination of two frames is carried out by executing a cross-correlation function with regard to any such combination of two frames, and that the value resulting from said cross-correlation function represents the said measure of identity.

It is explicitly remarked that the invention is also embodied in software carrying program-code for a computer to implement the above-discussed method and to a data carrier on which such software is loaded.

Further, the invention is embodied in a system for processing a series of image frames representing at least one cardiac cycle, which system comprises a computer and software to implement the afore-discussed method.

Hereafter the invention will be further elucidated with reference to a non-limiting exemplary embodiment and with reference to the annexed figures.

Figs. 1 and 2 show two image frames selected from a series of image frames representing a complete cardiac cycle.

Fig. 3 shows the result of a comparison of each frame with any other frame from the series of image frames.

Figs. 1 and 2 show a human heart at different moments of the cardiac cycle. A typical cardiac cycle consists of at least thirty of such frames as shown in Figs. 1 and 2 respectively.

According to the invention each frame from the series of frames (such as the frames shown in Figs. 1 and 2) is compared with every other frame from the series of frames and the result of the comparison is converted into a measure of identity.

Fig. 3 shows the collected measures of identity for all the possible combinations of pairs of frames from the series of frames representing a complete cardiac cycle. In this particular case Fig. 3 shows on both the horizontal and the vertical axis all frames from one series of frames, numbered 1-30, resulting in a total of $\frac{1}{2}N.(N+1)$ possible combinations in which N=30 is the total number of frames.

Fig. 3 shows the result of the comparison whereby the white areas represent full identity between the two compared frames and the darker areas represent less correspondence between the compared frames. The darkest areas represent the least correspondence between the compared frames.

Based on the above the areas marked with the arrows A and B relate to the combinations of frames showing the largest differences between the compared frames. Based on this result the systolic frame showing the contraction of the heart and the diastolic frame showing the heart in relaxed condition can be identified as frames 10 and 30 respectively.

Finally, it is remarked that the invention is not restricted to use with MRI-scans only. It can easily well be applied with CT-scans, ultrasound scans and any other scan that may be developed in future.

The invention can further easily well be applied with image frames from the heart taken from a perspective that differs from the frames shown in Figs. 1 and 2 respectively. The invention is insensitive to the viewing direction at which the heart under examination is being monitored. In short: the invention is not limited to the specific embodiment discussed above. This discussion merely serves to elucidate the appended claims without intending to limit the scope of protection of these claims.

CLAIMS:

1. Method for processing a series of image frames representing a cardiac cycle, in order to identify from said series of image frames a systolic frame showing a heart in its systolic phase, and a diastolic frame showing the heart is its diastolic phase, characterized by the steps that

a) each frame from said series is compared with every other frame from said series and a measure of identity regarding each such comparison between every combination of two frames is established, and that

b) a first frame and a second frame from said series of images showing the lowest value of said measure of identity, are selected, whereby the first frame is identified as the systolic frame and the second frame is identified as the diastolic frame.

2. Method according to claim 1, characterized in that the comparison between every combination of two frames is carried out by executing a cross-correlation function with regard to any such combination of two frames, and that the value resulting from said cross-correlation function represents the said measure of identity.

3. Method according to claim 1 or 2, characterized in that the series of image frames are derived from a group comprising a CT-scan, a MRI-scan, an ultrasound scan.

4. Method according to claim 3, characterized in that the series of image frames are derived from a MRI-scan.

5. Software carrying program-code for a computer to implement the method according to any one of claims 1-4.

6. Data-carrier loaded with software for operation on a computer to implement the method according to any one of claims 1-4.

7. System for processing a series of image frames representing a cardiac cycle, comprising a computer and software to implement the method according to any one of claims 1-4.

ABSTRACT:

The invention relates to a method for processing a series of image frames representing a cardiac cycle in order to identify from said series of image frames a systolic frame showing a heart in its systolic phase, and a diastolic frame showing the heart is its diastolic phase, comprising the steps that

a) each frame from said series is compared with every other frame from said series and a measure of identity regarding each such comparison between every combination of two frames is established, and that

b) a first frame and a second frame from said series of images showing the lowest value of said measure of identity, are selected, whereby the first frame is identified as the systolic frame and the second frame is identified as the diastolic frame.

Fig. 3

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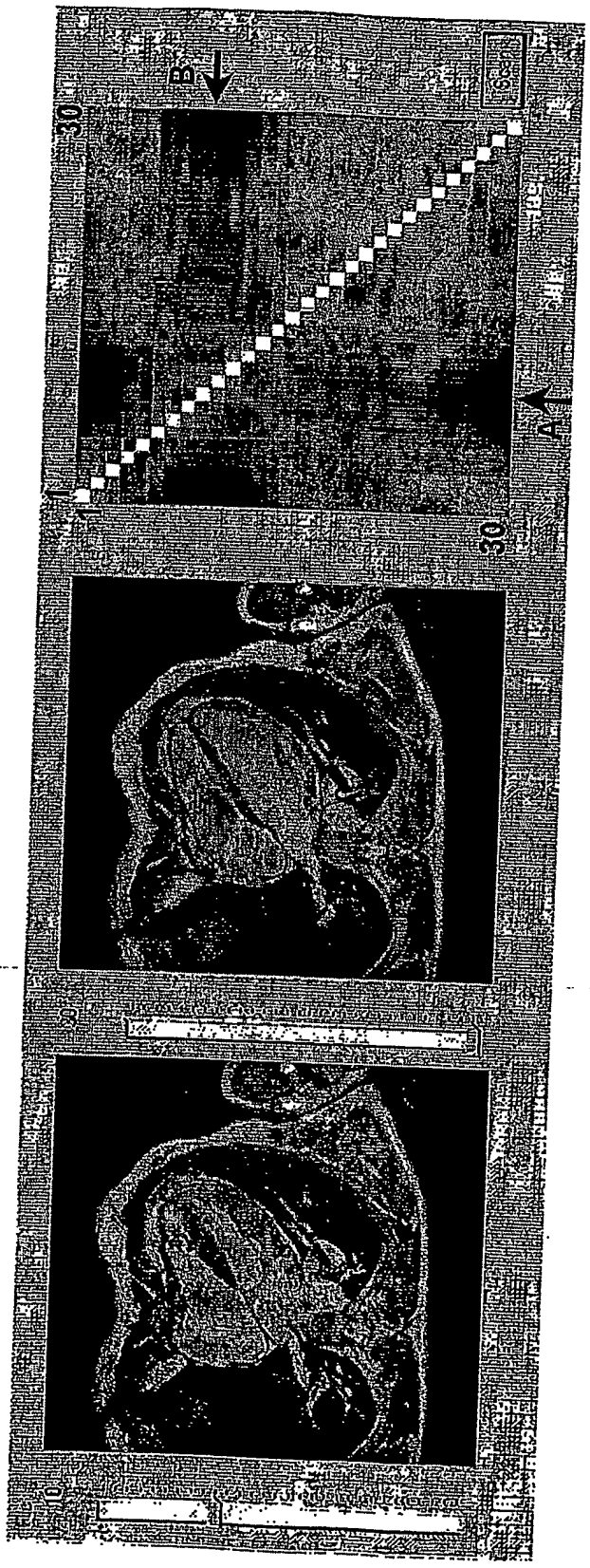

FIG.3

FIG.2

FIG.1

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